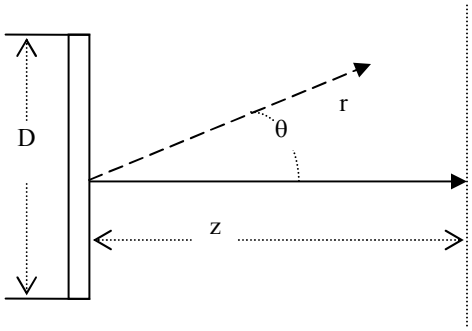
Flat Piston

- Near(Fresnel), Far(Frauhofer) zone transition

  $$Z = \frac{D^2}{4\lambda}$$

  D: diameter of the piston aperture.



- Intensity with depth along the z-axis in far field:

  $$I(z) = \frac{\pi D^2}{4\lambda z^2} I(0)$$

- General amplitude equation along the z-axis:

  $$A(z) = \frac{-2}{k} u_0 \sin\frac{k(\sqrt{\frac{D^2}{4} + z^2} - z)}{2} e^{-jk(\sqrt{\frac{D^2}{4}+z^2}+z))/2}$$

- Directivity:

  $$\phi(r,\theta) = -u_0 \frac{D^2 J_1(k\frac{D}{2}\sin\theta)}{4rk\frac{D}{2}\sin\theta} e^{-jkr}$$

- 3dB beam width: $\theta = \frac{0.25\lambda}{D/2}$

Focused Spherical Transducer:

- 3dB beam width: $B = 1.02\lambda F_{\#}$, $F_{\#} = \frac{Focus}{D}$
- Depth of focus: $D_F = 7.1\lambda F_{\#}$